ABSTRACT

My Experience Grouting Abandoned Coal Mines

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This paper presents my experience with the stabilization of abandoned mines from being directly involved with the grouting of over 1,000 holes with a variety of grout mixes. The projects involved stabilization of mine workings beneath roadways, buildings, dams, and disposal facilities. The main points are as follows:

Investigation

1. Borehole Cameras– Borehole cameras are an invaluable tool in helping to determine grouting procedures and quantities. For example, if voids of limited extent are observed in the mine roof, they can be grouted using the same mix as used for adjacent gob/caved material instead of changing to another mix. If voids in open mine workings are observed, they can be grouted using different procedures. Lights can be lowered into adjacent holes to help determine the extent of voids. Cameras also help to assess mine level water flow conditions.

2. Mine Maps – Mine maps are most useful if they are tied to surface features prior to drilling exploratory borings. Sometimes, the orientation of the map needs to be shifted during drilling to fit the conditions encountered in the grout holes. The mine maps also provide an indication of anticipated conditions, such as first or retreat mined, which impacts the investigation and grouting procedures.

Grout Mix

1. Grout Consistency – The consistency of the grout should be based on the characteristics needed to stabilize the conditions encountered at mine level. The consistency of many grout mixes is a result of strength requirements, which typically results in a grout mix which meets the strength requirements, but probably does not flow very far; therefore limiting its stabilization of an area. A better approach is to use a grout with its consistency based on the flowability needed to stabilize an area. For example, in areas with gob, rooffall, and/or roof voids, a grout with a 25 to 35 second flow cone value (“creamy soup” consistency) has been used successfully. And in open mine workings where it is desirable to create a barrier, a fly ash based concrete with a 4-inch slump has performed well.

2. Grout Strength - Use grout strengths based on 3 to 7 days instead of 28 days due to the cool, moist, and sometimes flooded conditions at mine level. A mix with some initial

strength gain, such as a strength of 300 psi in 7 days, results in a grout mix that should set up better than mixes using 300 psi in 28 days. The initial strength gain also helps to lessen the impact on strength of the grout mixing with mine water.

Grouting Procedures

1. Injection Quantities – Many grouting specs attempt to limit grout take to save money by using stage grouting, with 5 to 6 cy of grout being allowed to be injected in a hole per day. This approach may leave some areas unstabilized since it limits the lateral spread of the grout and may reduce roof contact. A better approach is to create barrier holes around the perimeter of the site and inject grout in interior holes until the hole is full; while checking for the presence of grout in adjacent holes. This approach also helps to assess the extent of stabilization. If the take seems excessive or the grout cannot be tracked, the grout can be thickened.

2. Takes in Holes Encountering Solid Coal – A grout hole encountering in-place coal usually takes enough grout to fill the volume of the hole. However, many times a "solid" will take if the fluid pressure of the grout in the hole is sufficient to fracture the coal in the side of the pillar so that the grout flows into the mined area. Significant grout takes have also been observed when the level of the grout in a "solid" hole reaches subsidence fractures in the roof rock above the mine workings or flows through fractures in "crushed" pillars, allowing the grout to flow into other areas of the mine. Crushed pillars are typically found in retreat mined areas and are due to its load being greater than its capacity.

3. Grout Hole Pattern – If the mine map can be tied to the site, basing the grout hole pattern on the mine map may reduce the number of holes needed to be drilled to stabilize an area when compared to using a standard grout hole pattern of holes at 25 or 30-foot centers. This results in fewer holes being drilled and a potential cost savings to the project. The mine map based grout holes are located to target entry intersections and rooms in the mine workings so that the grout is injected where it is needed most.